

AMENDMENTS TO THE CLAIMS

This listing of claims will replace all prior versions and listings of claims in the application:

LISTING OF CLAIMS:

1. (original): A system for estimating frequency offset in an orthogonal frequency-division multiplexing (OFDM) system, comprising:

a sliding window correlation summing device that receives an input and generates a sliding window correlation sum in accordance with a reference symbol; and

a frequency offset estimator that is coupled to said sliding window correlation summing device and receives and processes said sliding window correlation sum to calculate a frequency offset estimation, wherein said reference symbol comprises an analytic tone located in only one subchannel of said reference symbol.

2. (original): The system of claim 1, further comprising a timing offset estimator that receives said input and generates said timing offset estimation independent of said frequency offset estimation.

3. (original): The system of claim 2, said timing offset estimator comprising:

- a first delayer that delays said input in accordance with a first interval and a second interval, and generates a first delayed output;
- a second delayer that is coupled to said first delayer and delays said first delayed output in accordance with said first interval to generate a second delayed output;
- a conjugator that is coupled to said second delayer and performs a first operation on said second delayed output to generate a conjugated output;
- a mixer that is coupled to said conjugator and said first delayer and mixes said conjugated output and said first delayed output to generate a mixer output;
- a timing offset calculator coupled to said mixer and calculating a plurality of timing offset estimations in response to said mixer output; and
- a maximum value detector that is coupled to said timing offset calculator, detects a maximum value of said plurality of timing offset calculations from said timing offset calculator, and outputs said timing offset estimation.

4. (original): The system of claim 3, wherein said first interval and said second interval have different values, said first interval is a timing offset estimation interval and said second interval is a frequency offset estimation interval.

5. (original): The system of claim 3, wherein said timing offset calculator calculates said plurality of timing offset estimations for $(N+G-1)$ samples, wherein N represents

a total number of subcarriers, G represents a guard interval length, and a_1 represents a timing offset estimation interval.

6. (original): The system of claim 3, wherein said timing offset estimation is calculated by selecting a maximum value for the samples for which a second operation comprising ($\sum_{i=0}^{N+G-a-1} R_{n+1,a}^{(z)}$) is performed by said timing offset calculator for each of said samples.

7. (original): The system of claim 1, said sliding window correlation sum comprising:

a first delayer that delays said input signal in accordance with a frequency offset estimation interval to generate a first delayed output;

a conjugator that performs a first operation on said first delayed output to generate a conjugated output; and

a mixer that mixes said conjugated output and said input signal to generate a mixer output.

8. (original): The system of claim 7, wherein $(N-a_2)$ samples are generated in a moving sum in accordance with said mixer output, and N represents a total number of subcarriers and a_2 represents a frequency offset estimation interval.

9. (original): The system of claim 1, said frequency offset estimator comprising:
an analytic tone-phase compensation device that receives said sliding window correlation sum and performs a phase compensation operation to generate a phase-compensated output;
and
a frequency offset estimation calculator coupled to said analytic tone-phase compensation device and receiving said phase-compensated output and calculates said frequency offset estimation.

10. (original): The system of claim 9, said frequency offset estimation calculator comprising:
a first calculator that performs a first operation to generate a first calculated output; and
a second calculator that receives said first calculated output and generates said frequency offset estimation.

11. (currently amended): The system of claim 10, wherein said first operation comprises calculating $\tan^{-1} \left[e^{-ja\phi_b} \cdot \frac{\sum_{i=0}^{n-a-1} R_{\theta+c+i,a}^{(z)}}{\sum_{i=0}^{N-a-1} R_{\theta+c+i,a}^{(z)}} \right]$ and said frequency offset estimation comprises multiplying said first calculated output by $N/2\pi a$, wherein N is a number of total subcarriers and a is a number of samples.

12. (original): The system of claim 1, further comprising a switch that outputs said frequency offset estimation in accordance with said timing offset estimation.

13. (original): The system of claim 1, wherein an estimation range of said system can be extended by adjusting a correlation interval between samples.

14. (original): The system of claim 1, wherein said analytic tone has at least one of a uniform magnitude and a uniform phase rotation, and no coarse synchronization is required.

15. (original): The system of claim 1, wherein said frequency offset estimation is less than or equal to $(N/2a)$, wherein N represents a number of subcarriers and a represents a number of samples.

16. (original): The system of claim 15, wherein a maximum estimation range of the estimation is determined in accordance with said number of samples.

17. (original): The system of claim 16, wherein said maximum estimation range is ± 32 subcarrier spacing when N has a value equal to 1.

18. (original): A system for estimating frequency offset in an orthogonal frequency-division multiplexing (OFDM) system, comprising:

a sliding window correlation summing device that receives an input and generates a sliding window correlation sum in accordance with a symbol;

a frequency offset estimator coupled to said sliding window correlation summing device and receiving said sliding window correlation sum and calculates a frequency offset estimation in accordance with a timing offset estimation, said frequency offset estimator comprising,

an analytic tone-phase compensation device that receives said sliding window correlation sum and performs a phase compensation operation to generate a phase-compensated output, and

a frequency offset estimation calculator that receives that said phase-compensation output and calculates said frequency offset estimation, wherein an analytic tone is used in a correlation function; and

a timing offset estimator that receives said input signal and generates said timing offset estimation independent of said frequency offset estimation, wherein an estimation range can be extended by adjusting a correlation interval between samples, said analytic tone has at least one of a uniform magnitude and a uniform phase rotation, and no coarse synchronization is required.

19. (original): A system for estimating frequency offset in an orthogonal frequency-division multiplexing (OFDM) system, comprising:

a sliding window correlation summing device that receives an input and generates a sliding window correlation sum in accordance with a reference symbol; and

a frequency offset estimator that is coupled to said sliding window correlation summing device and receives said sliding window correlation sum to calculate a frequency offset estimation, wherein an analytic tone is used in a correlation function.

20. (original): The system of claim 19, further comprising a timing offset estimator that receives said input and generates said timing offset estimation independent of said frequency offset estimation, comprising:

a first delayer that delays said input in accordance with a first interval and a second interval to generate a first delayed output;

a second delayer coupled to said first delayer and delaying said first delayed output in accordance with said first interval to generate a second delayed output;

a conjugator coupled to said second delayer and performing a calculation on said second delayed output to generate a conjugated output;

a mixer coupled to said conjugator and said first delayer and adding said conjugated output and said first delayed output to generate a sum;

a timing offset calculator coupled to said mixer and calculating a plurality of timing offset estimations in response to said sum; and

a maximum value detector coupled to said timing offset calculator and selecting a maximum value from said plurality of timing offset estimators to output said timing offset estimation.

21. (original): A method for frequency offset estimation, comprising the steps of:
- (a) detecting an analytic tone located on only one subcarrier of a reference symbol of an input signal;
 - (b) generating a sliding window correlation sum in accordance with said analytic tone; and
 - (c) calculating a frequency offset estimation of said sliding window correlation sum.
22. (original): The method of claim 21, wherein a further step of generating said timing offset estimation independently of said frequency offset estimation comprises:
- (a) delaying said input signal in accordance with a first interval and a second interval to generate a first delayed output;
 - (b) delaying said first delayed output in accordance with said first interval to generate a second delayed output;
 - (c) performing an operation on said second delayed output to generate a conjugated output;
 - (d) mixing said conjugated output and said first delayed output to generate a mixed output;
 - (e) producing a plurality of timing offset estimations for a corresponding plurality of samples in response to said mixed output; and

(f) detecting a maximum value of said plurality of timing offset calculations to output said timing offset estimation.

23. (original): The method of claim 22, further comprising:

(a) generating said first interval as a timing estimation interval; and

(b) generating said second interval as a frequency offset estimation interval.

24. (original): The method of claim 22, said producing step comprising producing said plurality of timing offset estimations for $(N+G-a_1)$ samples, wherein N represents a total number of subcarriers, G represents a guard interval length, and a_1 represents a timing offset estimation interval.

25. (original): The method of claim 22, wherein said detecting step comprises selecting a maximum value for the samples for which said producing step comprises performing an operation comprising $(\sum_{i=0}^{N+G-a-1} R_{n+1,a}^{(z)})$ on each of said samples.

26. (original): The method of claim 25, said step (b) comprising:

delaying said input signal in accordance with a frequency offset interval to generate a first delayed output;

performing an operation on said first delayed output to generate a conjugated output; and

mixing said conjugated output and said input signal to generate a mixed output.

27. (original): The method of claim 26, comprising generating (N-a2) samples in a moving sum in accordance with said mixed output, wherein N represents a total number of subcarriers and a2 represents a frequency offset estimation interval.

28. (original): The method of claim 21, said calculating step comprising:
performing a phase compensation operation on said sliding window correlation sum to generate a phase-compensated output; and
receiving said phase-compensated output and calculating said frequency offset estimation.

29. (original): The method of claim 21, said calculating step comprising:
performing an operation to generate a calculated output; and
receiving said calculated output and generating said frequency offset estimation.

30. (currently amended): The method of claim 29, wherein performing said operation comprises calculating $\tan^{-1}\left[e^{-ja\phi_b} \cdot \frac{\sum_{i=0}^{n-a-1} R_{\wedge+c+i,a}^{(z)}}{\sum_{i=0}^{N-a-1} R_{\theta+c+i,a}^{(z)}}\right]$ and estimating said frequency offset comprises multiplying said first calculated output by $N/2\pi a$, wherein N is a number of total subcarriers and a is a number of samples.

31. (original): The method of claim 21, further comprising extending an estimation range by adjusting a correlation interval between samples.

32. (original): The method of claim 21, wherein said analytic tone is generated to have at least one of a uniform magnitude and a uniform phase rotation.

33. (original): The method of claim 21, wherein said frequency offset estimation is less than or equal to $(N/2a)$, wherein N represents a number of subcarriers and a represents a number of samples.

34. (original): The method of claim 21, further comprising changing a maximum estimation range of the estimation in accordance with said number of samples.

35. (original): The method of claim 34, wherein said maximum estimation range is ± 32 subcarrier spacing when N equals a value of 1.

36. (original): A method for frequency offset estimation, comprising the steps of:

- (a) detecting an analytic tone located on only one subcarrier of a reference symbol of an input signal;
- (b) generating a sliding window correlation sum in accordance with said analytic tone, said step (b) comprising,

delaying said input in accordance with a frequency offset interval to generate a first delayed output,

performing an operation on said first delayed output to generate a conjugated output, and

mixing said conjugated output and said input signal to generate a mixed output; and

(c) calculating a frequency offset estimation of said sliding window correlation sum in accordance with a timing offset estimation, said calculating step comprising,

(a) performing a phase compensation operation on said sliding window correlation sum to generate a phase-compensated output,

(b) performing a first mathematical operation to generate a first calculated output, and

(c) receiving said first calculated output and generating said frequency offset estimation; and

(d) extending an estimation range by adjusting a correlation interval between samples, wherein a correlation interval is adjusted such that no coarse tuning is required.

37. (original): The method of claim 36, wherein a further step of generating said timing offset estimation independently of said frequency offset estimation comprises

(a) delaying said input signal in accordance with a timing estimation interval and a frequency offset estimation interval to generate a first delayed output;

(b) delaying said first delayed output in accordance with said timing estimation

interval to generate a second delayed output;

(c) performing a calculation on said second delayed output to generate a conjugated output;

(d) adding said conjugated output and said first delayed output to generate a sum;

(e) calculating a plurality of timing offset estimations on a corresponding plurality of samples in a timing offset calculator and in response to said sum; and

(f) detecting a maximum value of said plurality of timing offset calculations from said timing offset calculator to output said timing offset estimation, wherein said detecting step comprises selecting a maximum value for the samples for which said calculating step comprises performing a mathematical operation comprising $(\sum_{i=0}^{N+G-a-1} R_{n+1,a}^{(z)})$ on each of said samples, and said frequency offset estimator is output in accordance with said timing offset estimation.

38. (original): The method of claim 37, wherein performing said operation comprises calculating $\tan^{-1}[e^{-ja\phi_b} \cdot \sum_{i=0}^{n-a-1} R_{\wedge+c+i,a}^{(z)}]$, and estimating said frequency offset comprises multiplying said first calculated output by $N/2\pi a$, wherein N is a number of total subcarriers and a is a number of samples.

39. (original): The method of claim 36, wherein said analytic tone is generated to have at least one of a uniform magnitude and a uniform phase rotation.

40. (original): A method for frequency offset estimation, comprising the steps of:
- (a) detecting an analytic tone of an input signal wherein said analytic tone has at least one of a uniform magnitude and a uniform phase rotation;
 - (b) generating a sliding window correlation sum in accordance with said analytic tone; and
 - (c) calculating a frequency offset estimation of said sliding window correlation.